

# An ontology for mammography screening recommendation

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# Motivating scenario: breast cancer prevention



Clinical Review & Education

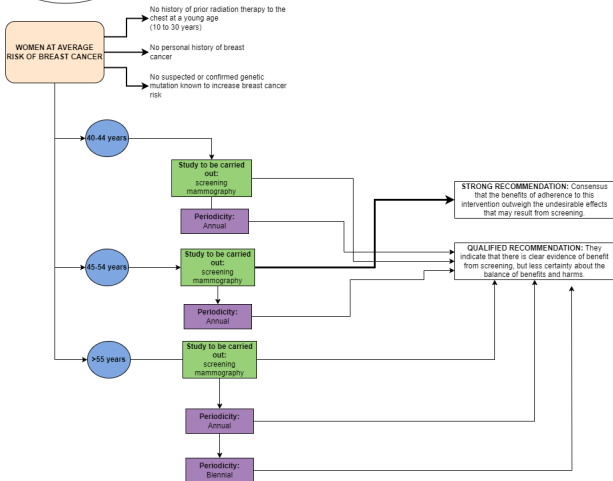
Special Communication

## Breast Cancer Screening for Women at Average Risk 2015 Guideline Update From the American Cancer Society







Kevin C. Oeffinger, MD, Elizabeth T. H. Forstam, MPH, DrPH, Ruth Etzioni, PhD, Abbe Herzig, PhD, James S. Michaud, PhD, Ya-Chen Tina Shi, PhD, Louise C. Walter, MD, Timothy R. Church, PhD, Christopher R. Flowers, MD, MS, Samuel J. Lillington, MD, Andrew M. D. Wolf, MD, Carol DeSantis, MPH, Joannie Lorlet-Toulet, MSc, Kimberly Andrews, Deana Marassaram-Baptista, PhD, Debbie Saslow, PhD, Robert A. Smith, PhD, Otis W. Brawley, MD, Richard Wender, MD



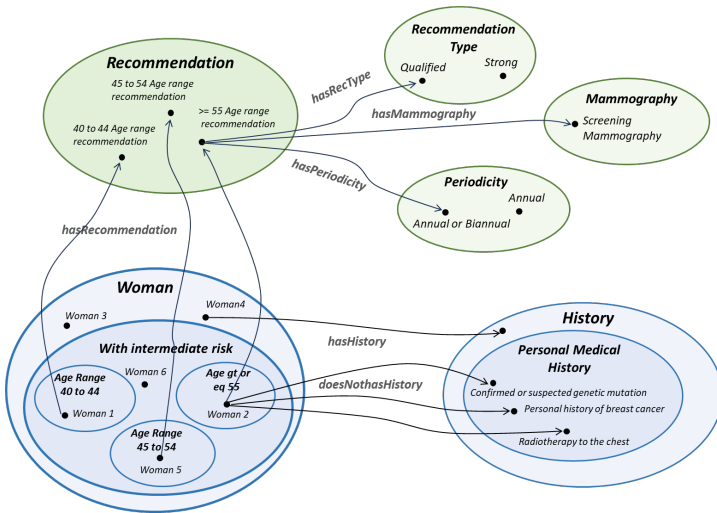
# The ACS guideline recommendations



## Related work

-  O. N. Oyelade, A. E. Ezugwu, S. A. Adewuyi, Enhancing reasoning through reduction of vagueness using fuzzy owl-2 for representation of breast cancer ontologies, *Neural Computing and Applications* 34 (2021) 1–26.
-  M. T. D. Melo, V. H. L. Gonçalves, H. D. R. Costa, D. S. Braga, L. B. Gomide, C. S. Alves, L. M. Brasil, *OntoMama: An Ontology Applied to Breast Cancer*, *Studies in Health Technology and Informatics* 216 (2015) 1104.
-  F. Jusoh, R. Ibrahim, M. S. Othman, N. Omar, Development of breast cancer ontology based on hybrid approach, *International Journal of Innovation in Computing* 3 (2013) 1.
-  O. Seneviratne, S. M. Rashid, S. Chari, J. P. McCusker, K. P. Bennett, J. A. Hendler, D. L. McGuinness, Knowledge integration for disease characterization: A breast cancer example, in: *Proceedings of the International Semantic Web Conference*, Springer, Monterey, CA, USA, 2018, pp. 223–238.
-  M. Tapi Nzali, J. Aze, S. Bringay, C. Lavergne, C. Mollevi, T. Optiz, Reconciliation of patient/doctor vocabulary in a structured resource, *Health Informatics Journal* 25 (2019) 1219–1231.
-  S. P. C. R. Krishnan, M. James, Mellrak: an ontology driven cdss for symptom assessment, risk assessment and disease analysis of breast cancer, in: *2021 International Conference on Software Engineering Computer Systems and 4th International Conference on Computational Science and Information Management (ICSECS-ICOCSIM)*, 2021, pp. 603–608.

# Mammography screening recommendation ontology



# Ontology restrictions: entailing recommendations

## Women classification

*With intermediate risk*  $\equiv$  *Woman*  $\sqcap$

*DoesNotHaveHistory*.{*Confirmed or suspected genetic mutation*}  $\sqcap$

*DoesNotHaveHistory*.{*Personal history of breast cancer*}  $\sqcap$

*DoesNotHaveHistory*.{*Radiotherapy to the chest*}

*Age Range 40 to 44*  $\equiv$  *With intermediate risk*  $\sqcap$   $\exists$ age.  $\geq$  40  $\sqcap$   $\exists$ age.  $\leq$  44

*Age Range 45 to 54*  $\equiv$  *With intermediate risk*  $\sqcap$   $\exists$ age.  $\geq$  45  $\sqcap$   $\exists$ age.  $\leq$  54

*Age gt or eq 55*  $\equiv$  *With intermediate risk*  $\sqcap$   $\exists$ age.  $\geq$  55

## Recommendation

*Age Range 40 to 44*  $\sqsubseteq$   $\exists$ hasRecommendation.{40 to 44 Age range recommendation}

*Age Range 45 to 54*  $\sqsubseteq$   $\exists$ hasRecommendation.{45 to 54 Age range recommendation}

*Age gt or eq 55*  $\sqsubseteq$   $\exists$ hasRecommendation.{55 Age range recommendation}

*hasRecommendation* o *hasRecType*  $\sqsubseteq$  *isRecommended*

*hasRecommendation* o *hasMammography*  $\sqsubseteq$  *isRecommended*

*hasRecommendation* o *hasPeriodicity*  $\sqsubseteq$  *isRecommended*

# Ontology restrictions: entailing recommendations

## Women classification

*With intermediate risk*  $\equiv$  *Woman*  $\sqcap$

*DoesNotHaveHistory*.{*Confirmed or suspected genetic mutation*}  $\sqcap$

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*Age gt or eq 55*  $\equiv$  *With intermediate risk*  $\sqcap$   $\exists$ age.  $\geq 55$

## Recommendation

*Age Range 40 to 44*  $\sqsubseteq$   $\exists$ hasRecommendation.{40 to 44 Age range recommendation}

*Age Range 45 to 54*  $\sqsubseteq$   $\exists$ hasRecommendation.{45 to 54 Age range recommendation}

*Age gt or eq 55*  $\sqsubseteq$   $\exists$ hasRecommendation.{55 Age range recommendation}

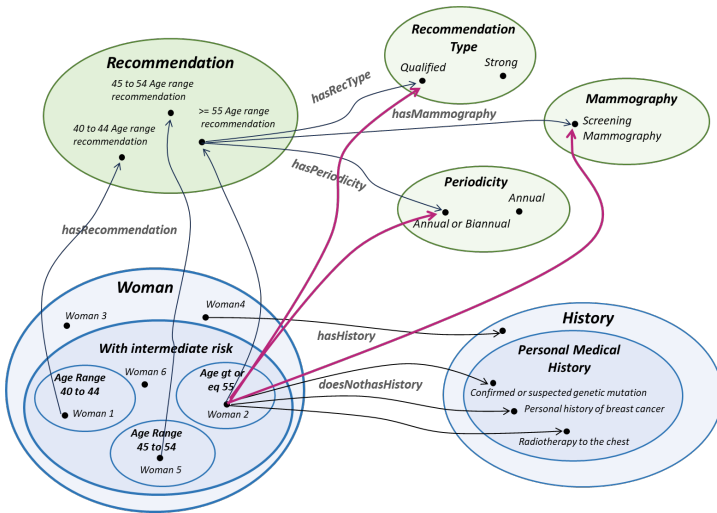
*hasRecommendation o hasRecType*  $\sqsubseteq$  *isRecommended*

*hasRecommendation o hasMammography*  $\sqsubseteq$  *isRecommended*

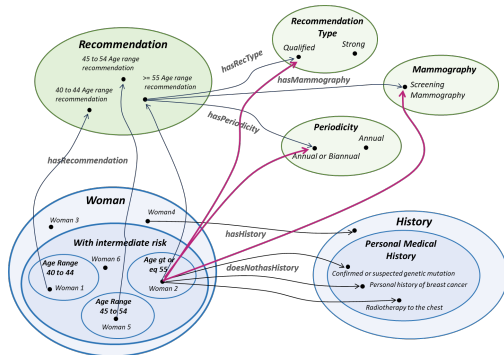
*hasRecommendation o hasPeriodicity*  $\sqsubseteq$  *isRecommended*



# Inference of direct recommendations



# Implementation of recommendations



**Description: Woman 2**

**Types**

- Woman
- Age gt or eq 55

**Same Individual As**

**Different Individuals**

- Annual, Annual\_or\_Biannual, 'Confirmed or suspected genetic mutation', 'Intermediate Risk', 'Personal history of breast cancer', 'Qualified Recommendation', 'Radiotherapy to the chest', 'Screening\_Mammography', 'Strong Recommendation', 'Woman 1', 'Woman 3', 'Woman 4', 'Woman 5', 'Woman 6', '>= 55 Age range recommendation', '40 to 44 Age range recommendation', '45 to 54 Age range recommendation'

**Property assertions: Woman 2**

**Object property assertions**

- doesNotHaveHistory 'Radiotherapy to the chest'
- doesNotHaveHistory 'Confirmed or suspected genetic mutation'
- doesNotHaveHistory 'Personal history of breast cancer'
- hasRecommendation '>= 55 Age range recommendation'
- isRecommended Screening\_Mammography
- isRecommended 'Qualified Recommendation'
- isRecommended Annual\_or\_Biannual

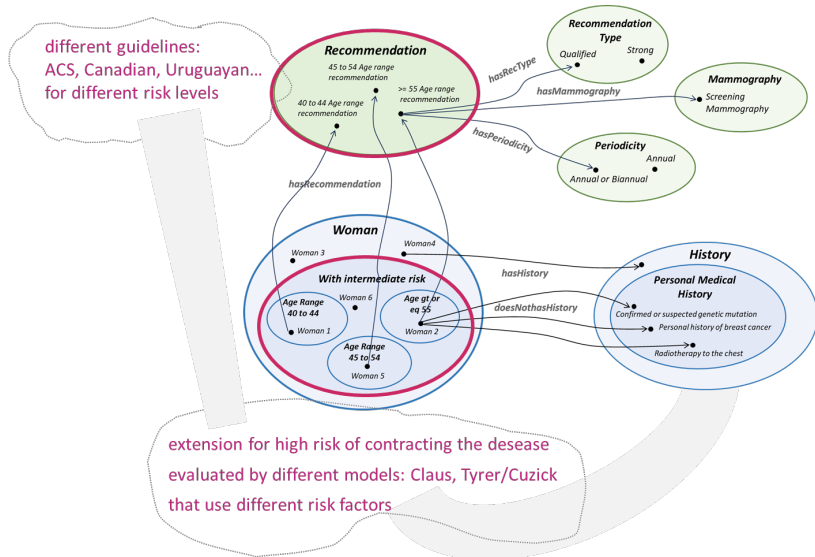
**Data property assertions**

- age 56

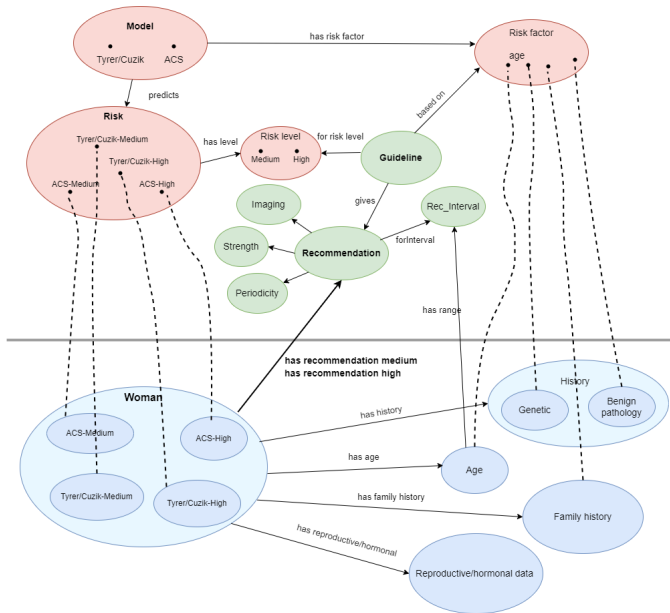
**Negative object property assertions**



# Work in progress: different models and guidelines



# Extended ontology for different models and guidelines



## Conclusions

The Mammography screening ontology provides personalized recommendations for the early detection of breast cancer in women at average risk of the disease

- based on the age range defines the strength and frequency of the screening mammography
- promising tool for doctor-patient communication and training of preservice health professionals
- allows medical professionals quick access to guideline recommendations in a non-verbose presentation
- simple design, allowing its extension and reuse

## Future work

- Validation of the extended ontology that entails recommendations for different risk levels evaluated by different models (work in progress)
- Validation of a framework that uses the extended ontology, by medical professionals of different health institutions
- Extension of the solution to other types of cancer and other diseases



Thank you!

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